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THE DEVELOPMENT OF LANGUAGE IN TWINS

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BY

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The Development of Language in Twins

I. A Comparison of Twins and Single Children[1]

ELLA J. DAY

INTRODUCTION

IN THE year 1886, Horatio Hale (17) in a paper published in the Proceedings of the American Association for the Advancement of Science, reported the case of a pair of twin boys who were so retarded in speech that members of the family could not understand them. These children lived in Boston in 1860. According to the report of an aunt, who visited them frequently, they developed a twin language so unlike English that they could not be sent to school because no one could understand them. Observation of the occasional development of such a special language by twins, suggested the problem of research undertaken here. The twin situation is, from an environmental point of view, quite unlike that of single children and it seemed possible that this might be a factor of considerable significance in the development of language.

[1] From the Institute of Child Welfare, the University of Minnesota, The Development of Language in Twins, Part II, The Development of Twins: Their Resemblances and Differences will appear in a subsequent issue. This will include a discussion of the mental development of twins, and a comparison of the types of twins in intelligence, language development and certain physical traits.

McCarthy's (13) investigation "The Language Development of the Preschool Child" provided an excellent basis for comparison. This study was completed in the summer of 1928 at the Institute of Child Welfare of the University of Minnesota. Dr. McCarthy selected 140 children (20 at each 6 months age level from 18 to 54 months) on the basis of sex and socio-economic status. She visited them and recorded 50 consecutive responses made by each child while he played with a group of toys that she presented to stimulate speech. These data were than analyzed in four different ways: by mean length of response; according to the Piaget functional analysis; by the grammatical construction of the sentence; and a word analysis by parts of speech. In brief the results indicated the developmental changes with age in agreement with other studies, as well as sex differences in favor of the girls. Differences in favor of the upper occupational groups were indicated also in each method of analysis. In the foreword to this study Dr. John E. Anderson says "On the basis of the number of controls utilized in the selecting of subjects and the care and thoroughness with which the data are analyzed, this monograph stands out as one of the best studies

of the development of language which has yet appeared." Thus the present investigation was planned to repeat the McCarthy technique using twins.

PURPOSE

The purpose of this investigation was to compare the development of language in twins with that of singletons of the same ages, sex, and socio-economic status.

2, 3, 4 and 5 years. Since McCarthy reports that 74 per cent of the responses of the 18 months old children were incomprehensible, it seemed adequate from the standpoint of the methods of analysis to be used, to begin with the 2 year age group. The wisdom of carrying the group on through the fifth year was not so apparent at the time the selection was made as the results now show it to be. An equal number

TABLE 1

Distribution of cases by age, sex and occupational class

OCCUPATIONAL CLASS	2 YEARS		3 YEARS		4 YEARS		5 YEARS		ALL (NUMBER OF PAIRS)	TWINS	MINNEAPOLIS POPULATION	MC CARTHY SINGLETONS
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls				
										per cent	*per cent*	*per cent*
I	1	1	2	0	0	2	1	1	4	5.0	5.4	5.0
II	2	0	1	1	0	2	0	2	4	5.0	6.3	6.4
III	7	9	8	8	10	6	9	7	32	40.0	37.3	35.7
IV	6	4	4	6	4	6	3	5	19	23.8	24.3	25.7
V	2	4	3	3	1	5	3	5	13	16.2	14.9	15.7
VI	2	2	2	2	4	0	4	0	8	10.0	11.8	11.4
Total....	20	20	20	20	19	21	20	20	80	100.0	100.0	100.0

SELECTION OF CASES

Through the courtesy of the Minneapolis and St. Paul Departments of Health, the writer had access to the birth registrations. The date of birth, sex, place of birth, name of physician attending the birth and the father's name, address and occupation were all recorded on the registration cards.

Subjects

Age and sex. After consideration of the findings of the McCarthy study, it was decided to select 80 pairs of twins, 20 pairs at each of four age levels, of boys and girls at each age were selected except at age four (see table 1) where there are 19 boys and 21 girls. These age groups are discrete because the records were taken within one month of the birthday. With the exception of one case where the records of the two children were not taken on the same day, the greatest deviation from the birthday was 38 days and the mean deviation for the whole group was 19.69 days. The one exception referred to deviated 99 days from the birthday.

Socio-economic status. The importance of securing a representative

sampling of the population is clearly brought out in such studies as the McCarthy study and the Goodenough (9) evaluation of the Kuhlman-Binet tests for children of pre-school ages. The sampling was made according to the Goodenough (10) classification of the Minneapolis population which was based on the application of the Barr Scale for Occupational Intelligence and the Taussig industrial classification to the 1920 census report of the occupations of males in Minneapolis between the ages of 21 and 45 years. The occupational levels are grouped into a six-fold classification. Group I consists of the professional vocations; group II the managerial occupations; group III the retailers, salesmen and skilled workmen; group IV the semi-skilled workmen; group V the drivers, helpers, etc.; group VI the day laborers. Table 1 shows the percentage of each occupational class found in the Minneapolis population and the percentages represented by the twins and singletons.

The distribution of the sexes is not equal at each occupational class but is equal in the upper three and lower three classes at each age, except at age four.

METHOD OF OBSERVATION

The language record

Just as the selection of cases was made on a basis similar to that used in the McCarthy study, the technique of obtaining the language record was carried out as it was with the singletons. A group of toys consisting of two linenette picture books, one of familiar animals and one of Mother Goose, a very small automobile, a rubber ball, a pasteboard cat that meowed when squeezed, a telephone with a bell, and a small music box were shown to the children to stimulate speech. In so far as possible, McCarthy's toys were duplicated exactly. The examiner requested to see each child alone but this was not always possible. The children were permitted to open the suitcase and look at the toys as they wished. The examiner remained out of the situation as much as possible because spontaneous responses were desired. Some conversations between the examiner and the child however always occurred. When members of the family insisted upon remaining in the room, they sometimes facilitated spontaneous speech on the part of the twin and sometimes interfered with obtaining an accurate record.

Fifty consecutive verbal responses were recorded and the time noted. The responses were recorded exactly as they sounded to the examiner. A response was denoted as complete when a distinct pause occurred. A complete sentence was always considered as a single response, although a single response might be either a complete or incomplete sentence. The mean time for obtaining such a record was 14.9 minutes for the twins as compared with 19.3 minutes for the singletons. The shorter time required by the twins is probably due to two factors. In the first place, they said considerably fewer words in the fifty responses. In the second place, the examiner was in the home anywhere from one to two and a half hours and at least one of the children had a somewhat greater opportunity to become adjusted to the presence of a stranger.

The examiner practiced taking such records with a group of children attending the nursery school at the University of Minnesota, preliminary to taking any records with the twins. She also had the advantage of being able to talk with Dr. McCarthy frequently and so check on minor differences in procedure.

The Intelligence tests

The Goodenough (18) drawing test of intelligence was given by the examiner to all the twins. This test consists merely in having the child draw a man. It is non-verbal and very simple to give. The results however were not useable since such a large percentage of the twins had not manipulated pencil and paper before and therefore they only scribbled.

The department of mental testing of the Institute of Child Welfare volunteered to give the twins the Minnesota Pre-school Scale, (11) which at this time was in the process of standardization. This test was devised by Goodenough and is a revision, for the most part, of the tests for these ages in the Kuhlman-Binet and the Stanford-Binet tests. Test results were obtained on 123 of the 160 children. A full discussion of these results will be presented in Part II.

METHODS OF ANALYSIS

McCarthy's methods of analysis were duplicated exactly. A total of 7,836 responses were made and of these 7,156 or 90 per cent were comprehensible and 780 or 10 per cent were classed as semi-comprehensible or incomprehensible.

Length of response

The comprehensible responses were analyzed first according to length of response. McCarthy set up the following arbitrary rules for this analysis:

(1) Contractions of subject and predicate like "it's" were scored as one word.
(2) Contractions of the verb and negative like "can't" were scored as single words.
(3) Hyphenated words and compound nouns functioning as single words like "Mother Goose" were scored as one word.
(4) Each part of a verbal combination was scored as a separate word.
(5) "Lookit" which occurred frequently was scored as one word if used alone although if followed by an object it counted as two words.

Functional analysis

According to Dewey the primary motive of language is to influence the activity of others. Young children in particular use language as it relates to their needs and give little heed to the adult usage of grammatical constructions and parts of speech. Piaget (16) working at the Institute Rousseau in Geneva developed such a functional classification which with slight revision was used by McCarthy:

A. Egocentric speech
   1. Repetition or echolalia
   2. Monologue
   3. Dual or collective monologue
B. Socialized Speech
   1. Adapted information
      (a) Naming
      (b) Remarks about the immediate situation
      (c) Remarks associated with the situation
      (d) Irrelevant remarks
   2. Criticism

3. Emotionally toned responses
4. Questions
5. Answers
6. Social Phrases
7. Dramatic imitation

Construction analysis

Until one undertakes the analysis of his own speech, or that of other adults, the extent to which adult speech falls short of grammatical standards of construction is scarcely realized. Many of the responses made in adult conversation are not structurally complete sentences, though because of what every adult knows to be implied, they are accepted in good everyday usage. The child patterns after the adults about him since as yet he is neither reading nor writing. For this reason McCarthy first divided the responses into the two groups complete and incomplete but included under the forms of complete sentences a group which were functionally complete but structurally incomplete. The outline of the classification used in this type of analysis is as follows:

A. Complete Responses
   1. Functionally complete but structurally incomplete responses
   2. Simple sentences without a phrase
   3. Simple sentences with a phrase
   4. Compound sentences
   5. Complex sentences
   6. Elaborated sentence, two phrases, two clauses or a clause and a phrase

B. Incomplete Responses
   1. Omission of the verb
   2. Omission of the subject
   3. Omission of a preposition
   4. Omission of a conjunction
   5. Omission of the verb and the subject
   6. Miscellaneous omissions (itemized)

Word analysis

Neither the McCarthy investigation nor the present study are primarily studies of the child's vocabulary. The nature of the experimental situation itself controlled somewhat the words the child used. For instance, by far the largest proportion of nouns used were the names of the toys and pictures shown the child. However, because of the number of children, and their selection, as representative of the Minneapolis population, an analysis of the words, according to the parts of speech, seemed warranted from the standpoint of showing their relative use, in a sample of running conversation.

The rules adopted by McCarthy for determining the number of different words used are similar to those developed by Bateman (1): They are as follows:

1. Include no proper nouns.
2. Include no plural form unless the singular was not used.
3. Include all forms of pronouns.
4. Include no variations of verbs or of adjectives unless they are from a different root.
5. The same word may be listed more than once according to its grammatical use; i.e., if a word is used as a noun and also as a verb, it is included twice.

RELIABILITY

Method of observation

In order to get some estimate of the degree of accuracy in recording such a verbal record, Dr. McCarthy, the examiner, and one other observer took records simultaneously, 25 responses

in length, on 10, two to five year old children, from a settlement house.

Table 2 shows the coefficients of reliability found between each two observers. The examiner first analyzed the language records as to length of response, the functional classification, and the construction of sentence category, just as the original data had been treated. The Spearman method of rank differences was used to determine the coefficients of reliability. In length of response the mean for each child according to each observer was used for the correlation and in the other analyses the percentage of whatever item was being correlated was used.

These coefficients seem sufficiently high to indicate reliability of the method of recording.

TABLE 2

Reliability coefficients on the method of recording

	OBSERVERS			
	1 and 2	1 and 3	2 and 3	Mean of all
	p	*p*	*p*	*p*
Mean length of response	.98	.99	.99	.99
Naming	.90	.99	.94	.94
Remarks about immediate situation	.95	.87	.94	.92
Functionally complete but structurally incomplete	.92	.91	.99	.94
Simple sentences	.32	.69	.72	.57
Incomplete sentences	.65	.40	.87	.64

Methods of analysis

The reliability of the various methods of analysis used in treating the language records was not determined in this investigation since McCarthy had determined this and found it to be high.

COMPARISON OF DATA ON LENGTH OF RESPONSE: TWINS AND SINGLETONS CHRONOLOGICAL AGE

The mean length of response is based upon a distribution of the responses. varying in length from one to nineteen words rather than upon a distribution of each child's mean length of response. Figure 1 shows a surprising difference in rate of language development for twins and singletons. At two years the difference is small but appears to become increasingly greater with age and is consistently in favor of the singletons. The mean length of response for the five year old twins is slightly below that of the three year old singletons. A retardation of two years in language development, one would think, was a serious handicap since contacts with our fellowmen depend so largely upon our ability to make ourselves understood verbally.

Critical ratios D/σ_D, computed for each age level were high and increased with age. At two years the ratio was 4.9; at 3, 11.6; and at 4, 15.3. Hence the superiority of singletons to twins in

language development is highly significant statistically.

Smith's investigation (18) of the development of the sentence and the extent of vocabulary in young children agrees very closely with the McCarthy results, and so only further emphasizes the handicap of the twins. The most rapid gain in length of response is made between two and three years by both twins and singletons. Although twins gain only one word in the entire year, singletons gain more than one word in the first half of the year. This difference in rate of development remains relatively the same up to five years. Smith feels that the relatively little gain in length of sentence after four or four and one-half years indicates that the sentence length has little value as a measure of sentence development after this age.

The question immediately arises as to when the curve of development for the twins turns and reaches the level of that of the singletons. Does the greater contact with other children, which occurs upon entrance in school, at or soon after the fifth year, stimulate language development sufficiently to give the twins this needed spurt? Does the twin situation so limit the child's environment in the early years of rapid development that he is always at a disadvantage? What is responsible for the retardation, heredity or environment, or both?

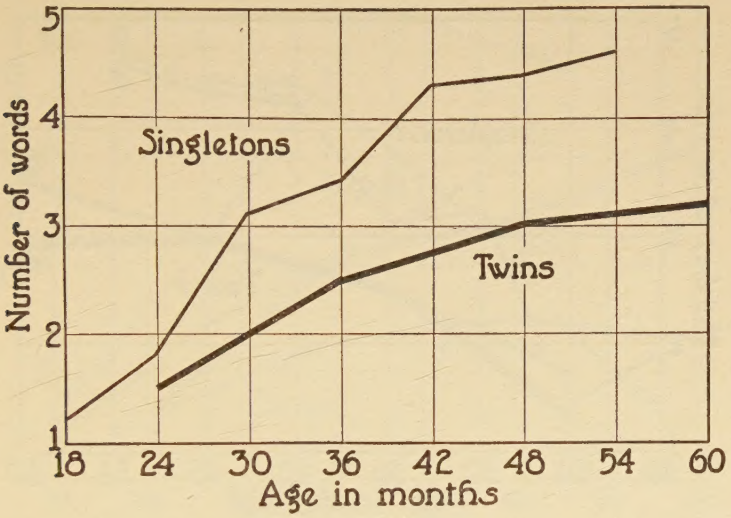

FIG. 1. MEAN LENGTH OF RESPONSE OF SINGLETONS AND TWINS BY CHRONOLOGICAL AGE

All of these questions and many more are as yet unanswered. Nevertheless the author has attempted to get what evidence she could to throw light on the problem.

Part II is devoted to a discussion of the mental ability of the twins but attention may be called at this time to the fact that the mental ability as well

as the language development of the twin group appears to be below average. The mean I. Q. for the whole group is 94. This is based upon the results of the Minnesota Pre-school Scale. The singletons, with whom the twins are compared have a mean I. Q. of 103.3, after the correction recommended by Goodenough has been applied. This correction is a subtraction due to Goodenough's observation that the Kuhlman-Binet test (the test used for the singletons) tended to score too high at the early ages. The singletons then appear to have been a group slightly superior even though they were so carefully selected. Had they been an average group the differences would be slightly decreased. That the twin group deviates even farther from normal is quite true although the evidence seems to be that this is a normal phenomenon rather than a matter of selection.

SEX DIFFERENCES

In agreement with the findings of McCarthy, Nice (15), Gale (6), Mead (14), Terman (20), and Doran (4), this reveals sex differences in favor of the girls. (See figure 2.) These differences are less marked than in the group of singletons at every age except four years, but are consistently in the same direction. It may be noted that at two years the twin girls are slightly superior to the single boys. The twin boys make a greater gain between two and three years than do twin girls but gain less thereafter. The differences between twin boys and girls at five years is greater than at any other age, while the greatest differences between the sexes in singletons was found at

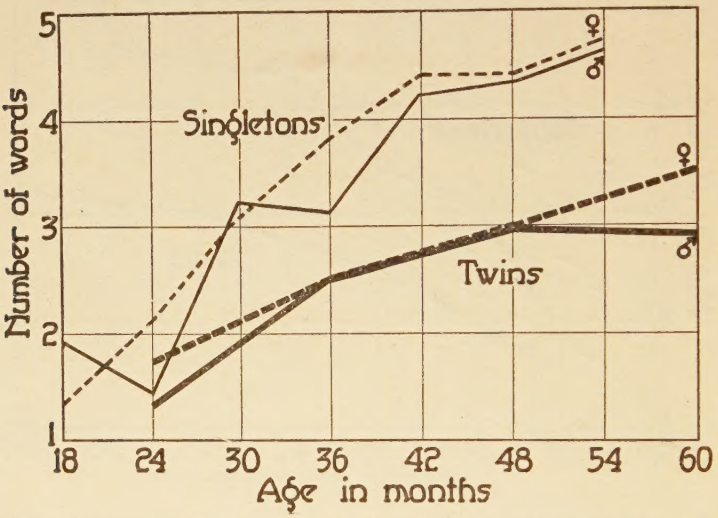

FIG. 2. MEAN LENGTH OF RESPONSE OF SINGLETONS AND TWINS BY SEX AND CHRONOLOGICAL AGE

two and three years. Smith does not report a consistent sex difference.

PATERNAL OCCUPATION

Because of the unequal number of cases in each of the six occupational classes the differences between occupational classes is most fairly shown by dividing the age groups into the upper three and lower three occupational classes. By so doing an equal number of cases and an equal number of each sex appears in each group. Figure 3 shows the expected differences between these groups. In comparing these results with the McCarthy results it must be noted that the age groups are not strictly comparable. The singletons were so grouped in reporting these findings that the age groups become 18, 27, 39 and 51 months, rather than at the exact year levels of the twins. The differences between twins and singletons are even more striking when based upon distribution by occupational class. That the singletons of the lower occupational groups are consistently above the twins of the upper groups presents a surprising picture of retardation. The mean of the differences at each age between upper and lower groups is .90 words for the singletons, .85 words for the twins so that the differences between upper and lower groups remain relatively the same. The fanning out of curves of the upper and lower group twins indicates that the difference increases with age, which

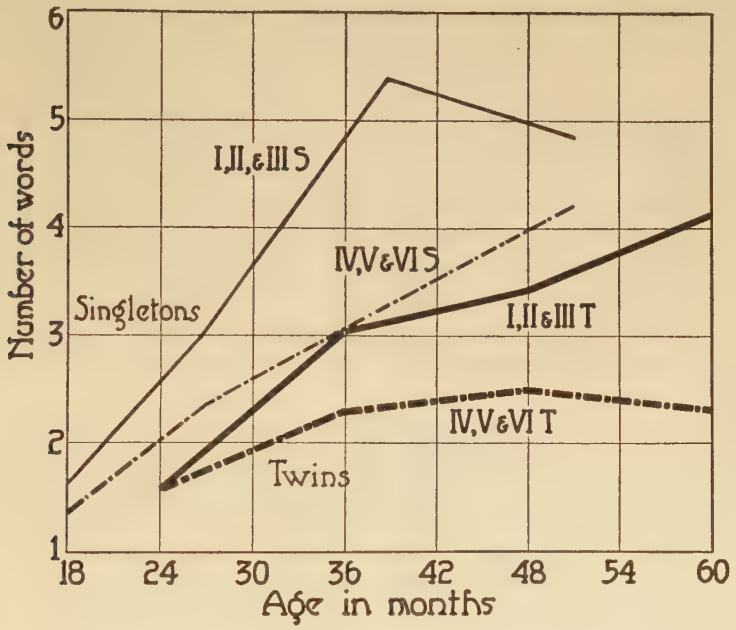

FIG. 3. MEAN LENGTH OF RESPONSE OF SINGLETONS AND TWINS BY UPPER AND LOWER OCCUPATIONAL GROUPS AND CHRONOLOGICAL AGE

suggests that environment plays a rôle in this.

COMPARISON OF DATA ON FUNCTIONAL ANALYSIS; TWINS AND SINGLETONS

The percentage of responses of the functional classification were worked out both inclusive and exclusive of the incomprehensible responses. Figure 4 shows the percentages of this classification based on all responses, including the incomprehensible responses.

When considered from the standpoint of age groups the incomprehensible responses, though somewhat fewer for twins at two years are slightly greater at three and four years and are still in evidence at five years. With the marked retardation in language development indicated by the differences in mean length of response of twins and single children, one might expect a very much greater percentage of incomprehensible responses on the

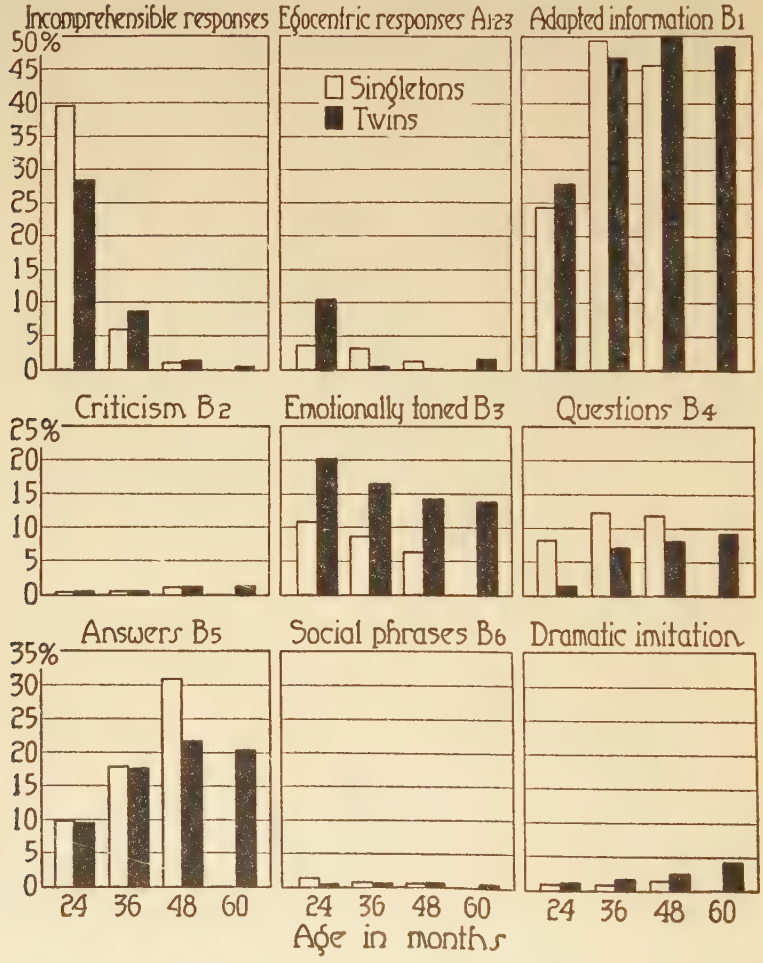

FIG. 4. FUNCTIONAL ANALYSIS OF SINGLETONS AND TWINS BY CHRONOLOGICAL AGE

part of the twin. Such responses do seem to persist for a longer time in the twins, however, which is suggestive of a slower development. Two factors in the twin situation may have acted to reduce somewhat the percentage of incomprehensible responses. It may be easier to understand short statements as compared with long ones and the twin data are composed of many more single word responses. Also, the examiner had had, just previous to making this study, two and one half years nursery school experience and was quite accustomed to interpreting the speech of young children. Dr. McCarthy on the other hand had had only the contact any adult may have with children previous to collecting her data.

The 780 incomprehensible responses include 83 semicomprehensible responses. Of 697 responses actually incomprehensible 287 or 41 per cent were single syllables, 121 or 17 per cent repetition of the same syllable and 289 or 42 per cent a series of different syllables. At two and three years the single syllables slightly exceed the others in number. At four and five years the series of different syllables is in the lead, in fact at five years, it is the only one represented. This type of incomprehensible response is no doubt a poor attempt at adult speech but the single syllables and repetition of the same syllable may be the voice play similar to that practiced by the young infant.

The three types of ego-centric responses described by Piaget are grouped together because each one appears to such a small extent. The twins, though they show more of this type of speech than the singletons at two years, show considerable less at three and four years, with an increase at five years. The twin situation of constant companionship, one might expect, would not be conducive to extensive ego-centric speech but rather to socialized forms of speech.

The different types of socialized speech are best presented in figure 5 where adapted information is divided into its sub-heads of naming, remarks about the immediate situation, remarks associated with the situation, and irrelevant remarks. Here too all percentages appear slightly increased since they are based upon comprehensible responses only.

Though as a whole adapted information shows increase with age and percentages in fairly close agreement with the singletons, when the four types of adapted information are considered separately differences between twins and singletons show up. Naming, the first type scarcely shows any decrease while with the singletons there is a marked decrease. That this function of language, typical of the two year old singletons but not so much so of the four year olds, persists through five years in the twins is indicative of maintenance of early language habits after they should have been dropped.

Remarks about the immediate situation increase with age but are present in greater numbers in twins than in singletons, whereas remarks associated with the situation are very few in number as compared with singletons, show relatively no increase with age, and do not appear at all until three years. In consideration of these two differences, one may wonder whether the limitations of the twin environment may account for these differences.

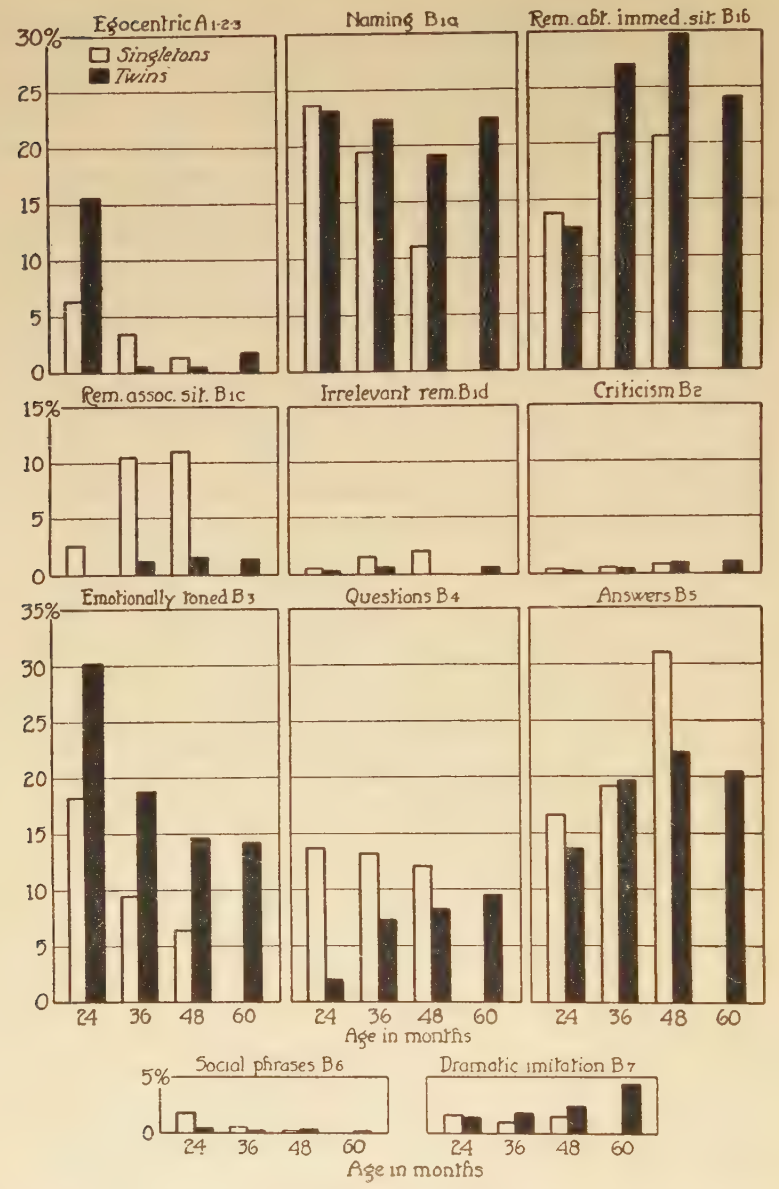

FIG. 5. FUNCTIONAL ANALYSIS OF SINGLETONS AND TWINS BY CHRONOLOGICAL AGE (BASED ON COMPREHENSIBLE RESPONSES)

The percentages of irrelevant remarks are comparatively insignificant. The singletons show a slight increase with age, however, which the twins do not show.

Criticism shows close agreement between twins and singletons and does increase with age.

The emotionally toned responses show one of the most striking differ-

ences between the two groups. Twins have almost double the per cent of the singletons at every age. Both show a decrease with age. This, like naming, is suggestive perhaps of persistence of infantile habits of language.

Questions increase with age in the twins but even at five years have not attained the per cent shown by singletons at two years. This no doubt is somewhat indicative of the retarded language development as well as of a high degree of satisfaction from companionship rather than from investigation of the environment.

Answers also increase with age but neither increase as much nor are present to so great an extent as with single children. This can not be attributed entirely to retarded development, however, since the extent to which the examiner asked the child questions determined to a considerable extent the percentage of answers given.

Social phrases though very much less at two years are slightly less at three years for twins than for singletons and greater at four years. Close companionship may be a factor here in reducing the need for such phrases.

Dramatic imitation increases very much with age and appears to be of greater significance in twins than in singletons. The social advantages of the twins through their companionship may bring this out somewhat more.

In considering the functional analysis as a whole it may be pointed out that the twins show retardation in those phases of the analysis which show the greatest developmental changes with age such as naming, emotionally toned responses, and questions. In ego-centric responses and dramatic imitation, however, they appear in advance of the singletons. These last two phases may easily be the result of close companionship.

As with the singletons, girl twins show some superiority over the boys in those items which make the greatest change with age. Comprehensive tables for these items are too detailed for publication. A large difference between boy and girl twins in incomprehensible responses at two years puts the girls quite inadvance of the boys. At three and four years the girls have a slightly greater percentage of incomprehensible responses, and at five they have less but these differences are so slight and the total percentage at three, four, and five years so small that the reversion is probably due to selection of cases.

The girls also show less ego-centric speech at every age except five years. The differences are small, however, except at two years, which is the most significant age from the standpoint of total percentage of this type of response.

In naming, the boy twins increase slightly while the girls decrease from the second to fourth year and then increase at five years. Girls have somewhat greater proportion of remarks about the situation and both boys and girls increase with age to four years then drop a bit at five years.

Girls increase more and are superior at all ages in remarks associated with the situation.

Emotionally toned responses are decidedly greater for the girls except at age three where a difference of only one per cent is in favor of the boys. The greatest differences in percentage of questions occurs at two years and is in favor of the girls. The other phases

of the functional analysis though they show some differences between the sexes show no striking or consistent trends.

The chief phases of analysis which showed marked differences between the upper three and lower three occupational classes are incomprehensible responses, ego-centric speech, questions, and remarks about the immediate situation. The greatest difference in incomprehensible responses is at two years where the upper class twins show about one-half as great a proportion as the lower class. Just the reverse situation is found in ego-centric speech. The lower group have slightly less than twice as much as the upper group at two years, and have none at all at the other ages. This was also the case with the singletons, except at thirty-nine months, where the lower group exceeded the upper group by quite a large proportion. Perhaps the sampling is not sufficient for these differences to mean a great deal since the percentage at any age is not very great. In both questions and remarks about the immediate situation the differences are not so marked at two and three years but become increasingly so at four and five years. The lower group shows a smaller proportion of these than the upper groups. A similar situation was found with singletons in regard to questions but not in regard to the other phase.

COMPARISON OF DATA ON CONSTRUCTION ANALYSIS: TWINS AND SINGLETONS

Chronological age

Figure 6 again shows that twins are retarded in language development as compared with singletons. Since they were found so retarded when measured by length of response one could scarcely expect to find them using many of the more complex forms of the sentence. It may be said, however, that in general the same tendencies with age are indicated in both the twins and singletons.

The functionally complete and structurally incomplete responses though they decrease with age are present to a somewhat greater extent in twins than in singletons. This group as has been stated, consists very largely of the single word responses. Although such responses appear rather commonly in adult speech they appear there largely in conversational usage while the young children employ them in other ways. For instance, in looking through the picture books it was not uncommon for the children to point at and name objects, and use no sentence at all. Twins evidently maintain this rather infantile manner of talking about what they see longer than do single children.

The simple sentence and all other forms of complete sentences increase with age but at every age are present to a considerably less extent than they are in singletons. The more complex the form of the sentence the greater the relative differences between twins and singletons become.

Incomplete sentences while not always present to a greater extent than in singletons do not drop off as rapidly. This again indicates persistence of early modes of talking or of rather infantile language habits.

The sex differences in sentence structure are not as marked for twins as singletons. There is no consistent

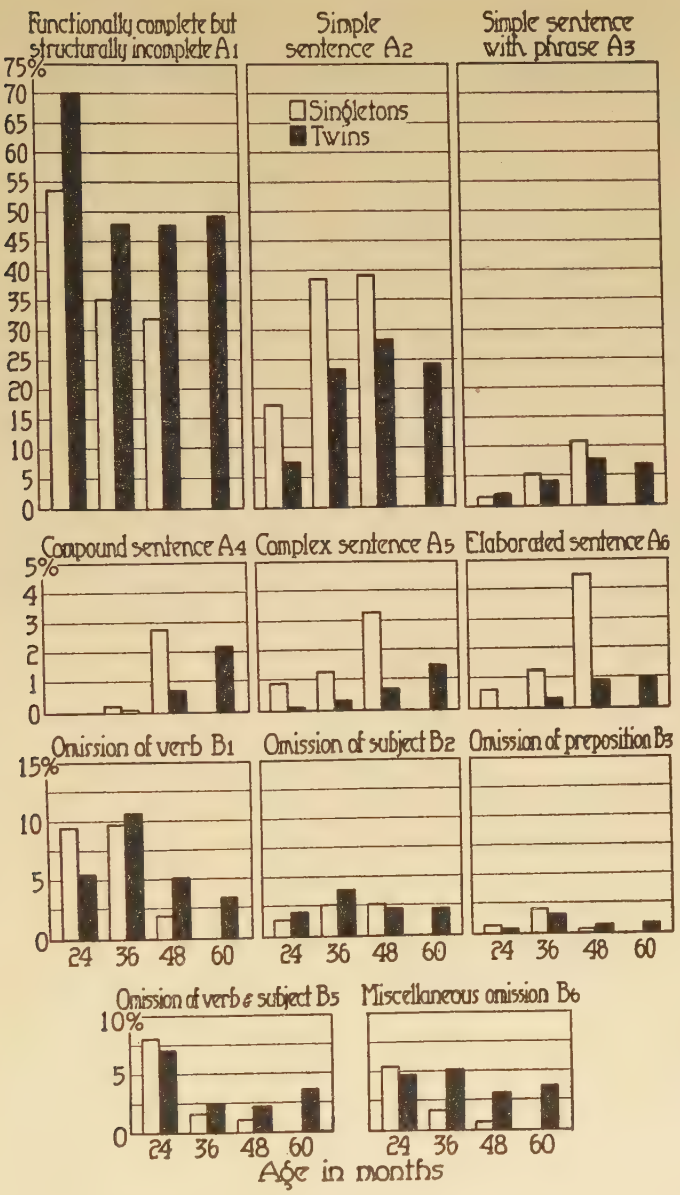

FIG. 6. CONSTRUCTION ANALYSIS OF SINGLETONS AND TWINS BY CHRONOLOGICAL AGE (EXCLUSIVE OF INCOMPREHENSIBLE RESPONSE)

trend in the differences between the boy and the girl twins in any of the items of the classification. It may be noted, however, that the girls do show all the forms of the complete sentence earlier and in larger proportion than the boys. Probably these items show the most important de-

velopmental changes with age and thus the girls may be considered in advance of the boys since they are using the more complex forms of the sentence earlier.

In relation to the singletons both boy and girl twins are retarded. In fact, as in the length of response, the girl twins rank below the boy singletons in practically all classifications of construction. Both sexes show the continuance of the functionally complete but structurally incomplete responses in much greater proportion than do singletons of the same age and sex.

When the responses are considered from the point of view of occupational class and construction of the sentence the differences are again found in favor of the upper groups.

The functionally complete but structurally incomplete responses are maintained in larger proportion through the fifth year by the lower groups and seem to indicate, as has been pointed out before, the continuance of a somewhat infantile habit of speech. All of the more complex forms of the sentence are present to a greater extent in twins from the upper groups than those from the lower groups. But as in the other analyses the upper group of twins is frequently below the lower group of singletons. In the comparison of two groups, however, it must be remembered that the singletons are so grouped that the age falls three months in advance of the age of the twins.

COMPARISON OF WORD ANALYSIS: TWINS AND SINGLETONS

These data were treated in two ways. Both the total number of words used by each child and the number of different words used by each child and each age group, were separated into the parts of speech.

Figure 7 shows the percentage of each part of speech of the total words used. Nouns show close agreement for twins and singletons both in the total percentage used and in the marked drop in percentage from two to three years. The percentage of verbs in which singletons show a gradual increase, from two to four years, is relatively much less at two years in twins, equal to the singletons at three years, and constant thereafter. Adjectives increase from approximately 2 per cent at two years to 8 per cent at five years, in twins. Singletons do not show this marked increase but even at two years have 10 per cent of adjectives, which exceeds the twin five year old percentage. Adverbs, except for a slight use at three years, are constant throughout and slightly greater in percentage in twins than in singletons. Pronouns increase with age to a greater extent in twins than singletons. They are, at every age, somewhat fewer in proportion. Con junctions are late in appearing. Girl singletons show a small per cent at eighteen months and the boys show none until thirty months. A smaller per cent (.9) appears at three years in the twins, and at five years the proportion is still smaller than that for singletons. Prepositions although they show a greater increase with age in twins than in singletons, at two are much less in proportion, the same at four years, and drop some at five years. Although interjections decrease with age markedly, the twins show a very much greater proportion at all ages,

especially at two years, than do singletons. This, no doubt, is related to the large porportion of emotionally toned responses which the twins showed in the functional analysis, and like it, is somewhat indicative of maintenance of infantile language. The miscellaneous parts of speech total words used by both singletons and twins. This shows differences similar to those in the mean length of response. The singletons have but a slight advantage at two years, but show an increasing advantage with age. The 158 words attained by the twins at five years are equaled in number by

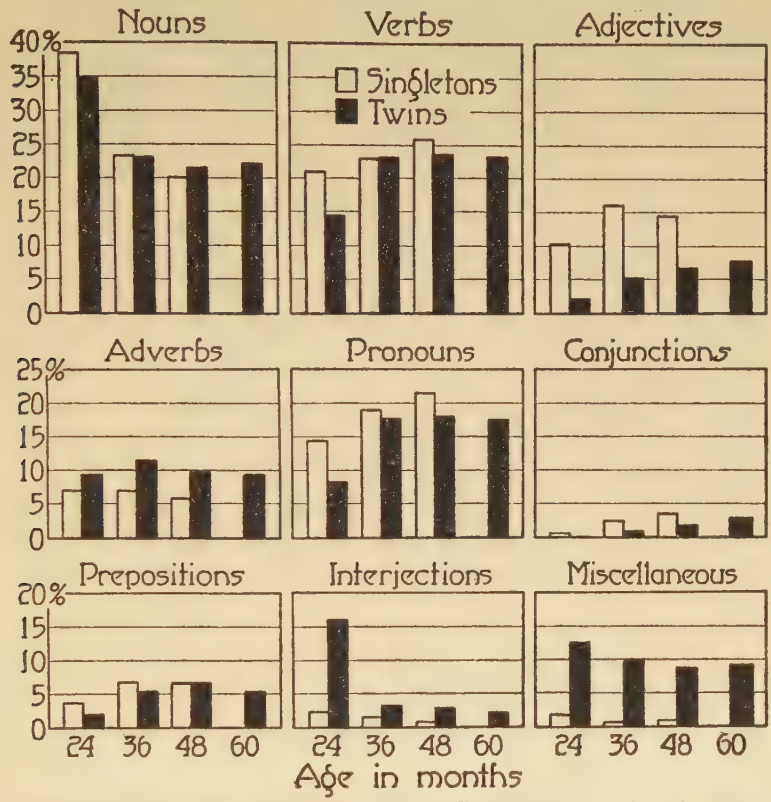

FIG. 7. PERCENTAGE OF PARTS OF SPEECH USED BY CHRONOLOGICAL AGE (BASED ON TOTAL WORDS USED)

include words which were difficult to classify more positively, such as "uhm-uh," "uh-uhm" used so frequently for "yes" and "no". These appear to be used to a considerably greater extent by twins than by singletons. This then seems to show a tendency to attain adult standards more slowly.

Table 3 shows the mean number of the singletons between thirty and thirty-six months. The retardation at five years is equivalent to approximately two years.

The percentage of different words of each part of speech used by each age group are presented in figure 8. It may be observed that the changes with age are not the same when considered

from the standpoint of percentage of different words used. For instance, the percentage of nouns remains relatively constant rather than decreasing with age. The child's vocabulary of nouns is actually increasing with age. The percentage of verbs remains relatively constant. Twins show a smaller percentage of verbs than singletons at all ages. Adjectives increase in percentage slightly with age in both groups. The percentage of adverbs

TABLE 3

Mean number of words used by C.A. and sex

CHRONOLOGICAL AGE	MEAN NUMBER OF TOTAL WORDS					
	Singletons (Mc Carthy)			Twins		
	Boy	Girl	All	Boy	Girl	All
months						
24	36.8	87.1	66.0	40.11	70.9	55.90
36	164.4	176.2	170.3	116.80	112.45	114.63
48	213.4	218.5	216.3	146.31	146.00	146.15
60				143.30	173.20	158.25

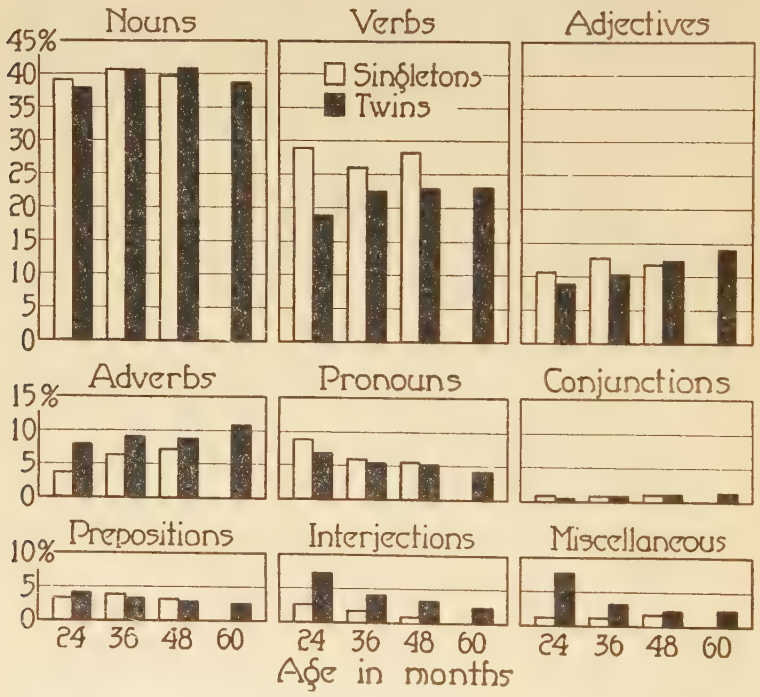

FIG. 8. PERCENTAGE OF PARTS OF SPEECH USED BY CHRONOLOGICAL AGE (BASED ON DIFFERENT WORDS USED AT EACH AGE GROUP)

increases with age more in the singleton group than in the twin group. Pronouns decrease in percentage with age although the actual number after three years remains about constant. Conjunctions increase in percentage a little in both groups and agree closely in total percentages. The percentage of prepositions decreases with age in twins and remains constant in singletons. Interjections decrease in percentage with age. The twins, however, show even at five years, a percentage almost equal to the two year old singleton. The miscellaneous words decrease with age and are higher in percentage for the twin group than for the singleton group.

The chief differences between singletons and twins in percentage of parts of speech used are in verbs, adjectives, pronouns, conjunctions and interjections. The twins differ from the singletons in showing a smaller percentage of verbs at two years, a smaller percentage of adjectives, pronouns and conjunctions at all ages, and a greater percentage of interjections at all ages. In the percentages of parts of speech of the different words, adjectives, pronouns and conjunctions do not show great differences in proportion between twins and singletons. Adverbs, interjections and verbs continue to show distinct differences. Twins show a greater percentage of adverbs and interjections and a smaller percentage of verbs.

The sex differences in percentage of parts of speech, of the total words used, are of the same order as in the singleton group although they are less in magnitude in most instances. Girls are in advance. The greatest differences appear at two years, indicating, perhaps the earlier linguistic maturity of the girls.

The total number of words used also favors the girls. As in the mean length of responses, the boy and girl twins do not differ at three and four years although they show striking differences at two and five years. In the number of different words used (table 4) girls are superior at every age except three years, when the boys exceed by 19 words, the majority of which are verbs.

The twin group when divided into the upper and lower occupational classes shows differences similar to those found in the singletons. The upper group shows a superiority which is most marked at two years in those parts of speech of greatest developmental significance. This may in-

TABLE 4

Mean number of different words used by twins and singletons

YEARS	TWINS						SINGLETONS (MC CARTHY)					
	No cases	Boys	No cases	Girls	No cases	All	No cases	Boys	No cases	Girls	No cases	All
2	19	16.4	20	24.2	39	20.4	8	16.6	12	37.3	20	29.1
3	20	45.4	20	45.1	40	45.3	10	60.1	10	66.0	20	62.8
4	19	59.1	21	56.1	40	56.5	9	91.1	11	93.8	20	92.6
5	20	61.3	20	69.4	40	65.3						

dicate an earlier linguistic maturity of twins from the upper occupational classes.

Descoeudres (2), Drever (5), Gesell and Lord (7), Hertzer and Reindorf (12), Smith and McCarthy all have obtained results which agree in showing a positive relationship between linguistic development and socio-economic status. Stern (19) in reworking the Descoeudres data estimated the difference between educated and working class children to be equivalent to about 8 months in age.

SUMMARY

1. As compared to single children twins are retarded in language development, as measured by each of the methods of analysis used.

2. This language retardation increases with age, within the age period covered (2–5 years) and is most clearly shown in the comparison of the findings of mean length of response.

3. Both in the analysis according to the structure of the sentence, and in the world analysis, twins show the greatest retardation in those phases which make the greatest change with age.

4. This is also true in the functional analysis with the exception of two phases. Ego-centric responses and dramatic imitation, which are both affected, probably by the social advantage of the twin situation, show a superior development in twins as compared with singletons.

5. A small sex difference in favor of the girls appears in all methods of analysis. These sex differences are not as great as in the case of singletons, due possibly to the operation of the social factor.

6. Twins of the upper three occupational classes are superior in all methods of analysis to the twins of the lower three occupational classes.

7. Singletons of the lower three occupational classes are superior in mean length of response to the twins of the upper three occupational classes. They are frequently superior in the phases of the other analyses.

8. The twins in this study were found to be approximately ten points below the I.Q. of the slightly superior group of singletons with whom they were compared.

If in the twin situation each child has the other for a model in speech a large proportion of the time, rather than adults or older children as in the case of singletons, perhaps we may expected slower progress with a poorer model. Nothing in the situation prevents two children from listening simultaneously to what adults say, although the time spent in practicing speech might be limited and considerably reduced. In the first place only one person can talk at a time and in the second place perhaps the activities or even the presence of a twin provide some of the satisfaction otherwise obtained from conversation. Whatever the factors may be however, the evidence is clear that during the preschool years twins progress toward adult use of language at a relatively slow rate.

REFERENCES

(1) BATEMAN, W. G.: Two children's progress in speech with detailed vocabularies. Jour. Educ. Psychol., **6**, 1915, 475–493.

(2) DESCOEUDRES, ALICE: Le développement de l'enfant de deux à sept ans. Neuchâtel and Paris; Delachaux and Niestle, 331 pp.

(3) DEWEY, J.: The psychology of infant language. Psychol. Rev., 1894, **1**, 63–66.

(4) DORAN, E.: A Study of Vocabularies. Ped. Sem., 1907, **14**, 401–438.

(5) DREVER, J.: The vocabulary of a free kindergarten child. Jour. Exper. Ped., 1919, **5**, 28–37.

(6) GALE, M. C. and GALE, H.: The vocabularies of three children in one family at two and three years of age. Ped. Sem., 1902, **9**, 422–435.

(7) GESEL, A. AND LORD, E.: A psychological comparison of nursery-school children from homes of low and high economic status. Ped. Sem., 1927, **35**, 339–356.

(8) GOODENOUGH, FLORENCE L.: Measurement of intelligence by drawings. World Book Co., 1926, pp. 177.

(9) GOODENOUGH, FLORENCE L.: The Kuhlman-Binet Tests for children of preschool age. A critical study and evaluation. University of Minnesota Press., pp. 146.

(10) GOODENOUGH, F. L. and ANDERSON, J. E.: Experimental child study. The Century Co., pp. 546.

(11) GOODENOUGH, F. L., FOSTER, J. C. and VAN WAGENEN, M. J.: Minnesota pre-school scale. Educational Test Bureau Inc., Minneapolis.

(12) HERTZER, H. and REINDORF, B.: Sprachentwicklung und soziales Milieu. Zsch. f. angew. Psychol., 1928, **29**, 449–462.

(13) MCCARTHY, DOROTHEA A.: The language development of the pre-school child. University of Minnesota Institute of Child Welfare Monograph Series No. **4**, Minneapolis, University of Minnesota Press, 1930, pp. 174.

(14) MEAD, C. D.: The age of walking and talking in relation to general intelligence. Ped. Sem., 1913, **2**, 460–484.

(15) NICE, M. M.: Length of sentence as a criterion of a child's progress in speech. Jour. Educ. Psychol., 1925, **16**, 370–379.

(16) PIAGET, J.: The language and thought of the child. (Trans. by M. Warden) New York, Harcourt Brace, 1928, pp. 260.

(17) ROMANES, GEORGE JOHN: Mental Evolution in Man. D. Appleton Co., 1889, pp. 452.

(18) SMITH, M. E.: An investigation of the development of the sentence and the extent of vocabulary in young children. University of Iowa. Studies in Child Welfare, **3**, No. 5, Iowa City, 1926, pp. 92.

(19) STERN, W.: Psychology of early childhood up to the sixth year. (Trans. by A. Barwell from the 3rd edition) New York: Holt, 1924, pp. 557.

(20) TERMAN, LEWIS H. et al.: Genetic Studies of Genius. **1**. Stanford University Press, 1925.

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The Development of Language in Twins

II. The Development of Twins: Their Resemblances and Differences[1]

ELLA J. DAY

INTRODUCTION

MAN'S curiosity in the unusual has led him into many fields of adventure. Twins, constituting about one per cent of the births according to Davenport (3) are both so rare and so different that science has for a long time been very curious about their origin, their resemblances and their differences. The dispute as to the relative importance and effects of heredity and environment in moulding human nature dates back to the ancient Greek philosophers and scientific workers always have felt that twins presented a special opportunity for making such studies.

Newman's (16) investigations on the star fish and the Texas armadilla as well as his more recent studies of twins, point unquestionably to the fact that there are 2 types of twins. The identical or monozygotic twins arise from the splitting of a single zygote while the fraternal or dizygotic twins arise from the simultaneous development of two zygotes. The psychological studies of twins beginning with that of Galton (4) in 1883 also give evidence of the two types of twins, in that they show a greater degree of resemblance in both physical and mental traits in identical twins than in fraternal twins. Thorndike (19) in 1905 disputed this fact. The later investigations of Merriman (14), Lauterbach (12), Gesell, (5, 6), Muller (15) and Wingfield (22) however have all supported the theory of the monozygotic origin of identical twins.

This investigation, though undertaken primarily to compare language development in twins with that in single children, also obtained sufficient information in regard to the twins studied to determine fairly accurately whether or not they were identical or fraternal twins. With these data at hand, the three types of twins, identical, like-sex fraternal and unlike-sex fraternal were compared as to resem-

[1] From the Institute of Child Welfare, the University of Minnesota. The Development of Language in Twins, Part I, A Comparison of Twins and Single Children appeared in Child Development (Vol. 3, No. 3). It reported the language development of 80 pairs of 2 to 5 year old twins and compared their development with that of the single children reported by D. A. McCarthy (13) in The Language Development of the Preschool Child. McCarthy's method and technique were repeated throughout. The tables of Part 1 and 2 are numbered continuously.

blances and differences in language attainment, mental test performance and certain physical characteristics.

Subjects

Eighty pairs of twins, 20 at each age level, 2, 3, 4, and 5 years, were selected on the basis of sex and occupational class. Like-sex twins were selected in preference to unlike-sex twins in an effort to obtain a larger number of identical twins in the group. Table 5,[2] shows the distribution of cases by age, sex and type of twin.

The percentage of both identical (23.75) and unlike-sex twins (28.75) is low for a representative sampling of the twin population. The like sex fraternal group is proportionately high.

TABLE 5

Distribution of cases by age, sex and type of twin

TYPE OF TWIN	2 YEARS		3 YEARS		4 YEARS		5 YEARS		TOTAL	
	Boys	Girls	Boys	Girls	Boys	Girls	Boys	Girls	Pairs	Per cent
Like sex identical	8	10	2	4	2	6	4	2	19	23.75
Fraternal	8	6	10	8	12	10	10	12	38	47.50
Unlike sex	4	4	8	8	5	5	6	6	23	28.75

Procedure

Information in regard to the development, likenesses and differences of the twins was obtained largely by means of a questionnaire. This was filled out in consultation with the mother at the same time that the language record was obtained.

Information about the family included parents' birthplaces, education, and occupation; names, and ages, and age of talking of other children; foreign language spoken in the home; policy of the family with regard to speech of the twins; age, sex, and speech of the twins' playmates; leadership and emotional habits of the twins; and whether the family considered them identical.

Specific information obtained on each twin included physical defects, sensory handicaps, serious illnesses, age of walking, talking, first tooth, handedness, thumb sucking, and other nervous habits, play interests, self-help in eating, dressing and toilet habits, and hair and eye color.

In addition to this information records were obtained, where possible, from the hospital or physician, as to the number of placentae reported at the delivery of the twins. Later, when the question arose as to the possible relationship of prematurity of birth to the apparent mental retardation of the twins, a questionnaire was sent to the mother, asking for the following information: Order of birth of the twins, whether or not the twins were born at full term and if not how much they varied from it, whether or not twinning had appeared in any of the relatives of the mother or the father. Seventy of the 80 parents, or 87.5 per cent replied to this questionnaire.

[2] Tables are numbered consecutively from Part 1.

THE MENTAL DEVELOPMENT OF THE TWINS

The language retardation of the twins, evident in every method of analysis, suggests at once, the possibility of a similar mental retardation. Merriman was the first to use the present day intelligence test as a device for measuring mental ability of twins and so he was the first one to report I.Q.'s on a large group. Although he found the mean I.Q. of 105 pairs to be 96, he assumed that the slight retardation was due to selection of cases and was not to be interpreted as indicating mental inferiority of twins as a whole. Wingfield (22) on the contrary, concluded from his study, that twins were from 1 to 2 per cent below average in intelligence.

INTELLIGENCE OF THE TWINS

The twins of the present study were given the Minnesota Pre-school Scale[3] as described in Part 1. Test scores were obtained on only 123 of the 160 children. In a few more cases, tests were attempted but a satisfactory test was not obtained. The remainder of the group failed to coöperate to the extent of allowing the tests to be given. The range of I.Q.'s for the twin group was from 59 to 138.

Table 6 shows the mean I.Q.'s by age and sex of the twins and singletons.

It may be seen, as has been pointed out previously, that the twin group is consistently below average, with the exception of the two year old and five year old girls. The singleton group, on the contrary, are slightly superior, except at the three year age group which is approximately average. The tests used in the two instances were not the same. The singletons were given the Kuhlman-Binet test and the twins were given the Minnesota Pre-school Scale (9). However this scale is composed largely of the individual tests from the Kuhlman and Stanford-Binet tests; hence the actual items of each test do not differ greatly. Boys are inferior to girls at every age in both groups, except at three years. Since the selection of the two groups is so nearly identical, the evidence points rather directly toward slight inferiority of the twin

TABLE 6

Mean I.Q. of twins and singletons by age and sex

C.A.	TWINS					SINGLETONS (MC CARTHY)		
	Boys		Girls		All—Mean I.Q.	Boys—Mean I.Q.	Girls—Mean I.Q.	All—Mean I.Q.
	Number of cases	Mean I.Q.	Number of cases	Mean I.Q.				
years								
2	14	89.0	11	103.0	95.0	102.4	109.4	106.9
3	15	95.0	18	93.0	94.0	100.5	97.7	99.3
4	18	90.0	17	92.0	91.0	101.8	103.8	103.8
5	14	95.0	16	101.0	98.0			

[3] This scale was in the process of standardization at the time this investigation was made.

group in general intelligence as it was measured.

Not only are the upper occupational groups superior to the lower occupational groups in each cases, but the lower occupational group of singletons is superior to the upper occupational group of twins. A similar situation was apparent in regard to mean length of language response. The slight differences in the percentage of each population, taken from the upper and lower occupational groups, favors the twin group. Exactly 50 per cent of the twin group fall in the three upper groups as compared with 47.1 per cent of the singleton group.

The most interesting evidence in regard to the intellectual inferiority of twins may be seen by a comparison of the findings of the various twin studies. (See table 7) Here the data from the Wingfield, Freeman[4] and Merriman studies have been assembled and to some extent reworked, from their original data, to get the desired means. This group of studies, including the present study, represent a total population of 737 twin children of 368.5 pairs. The range in age is from two to about sixteen years. The intelligence tests used have been standard tests. Only one mean I.Q. in the table is as high as 100 or above, and that is for the 50 pairs of identical twins examined by Freeman. In addition to those data, the Lauterbach data give a mean I.Q. of 95 for that twin group. This adds about 200 pairs of twins to the population considered, making a total of 568 pairs. The mean I.Q. for this entire group of 568 pairs of twins is 96.3. Such a sampling as this, showing consistent mean I.Q.'s from 1 to 6 points below the average I.Q. of 100, for the population as a whole, is surely sufficient evidence to confirm Wingfield's conclusion, that twins are, as a group, slightly below the average in intelligence as measured.

TABLE 7

Mean I.Q. of like-sex and unlike-sex twins as found by the different investigators

	DAY		WINGFIELD		FREEMAN		MERRIMAN		TOTAL	
	Number	I.Q.	Number	I.Q.	Number	I.Q.	Number	I.Q.	Number	I.Q.
Like sex	88	93.5			200	98.8			288	97.2
Identical	27	99.7	90	99.0	100	101.6	44	98.0	261	99.9
Fraternal	61	90.8	62	92.9	100	96.1	90	96.2	313	94.5
Unlike sex	35	96.2	52	98.6			76	94.7	163	96.3
All fraternal	96	92.8	114	95.7			166	95.5	376	94.9
All twins	123	94.3	204	97.2	200	98.8	210	96.0	737	96.8

COMPARISON OF THE INTELLIGENCE OF IDENTICAL LIKE-SEX

Fraternal and Unlike-sex twins

Dr. Freeman in making a preliminary report of the twin study being conducted at the University of Chi-

[4] Investigation now under way in collaboration with Newman and others at University of Chicago. These figures came from mimeographed notes presented by Dr. Freeman at a lecture.

cago, called the attention of the writer to the possible differences in mean I.Q. between identical and fraternal twins. In order to obtain such information in regard to the groups studied, by the other investigators, their original data were worked over. Wingfield and Freeman distinguish their twins as identical, like-sex fraternal or unlike-sex. For the Merriman study, a group denoted, "reported as very similar" in appearance were selected by the writer as the nearest approach to an identical group. The necessary original data for the Lauterbach study could not be obtained. In the Thorndike group, 11 pairs, who from the data on physical measurements appeared to be most nearly alike were selected as possible identical twins. Those data did not give I.Q.'s but the mean deviation from the mean of the composite score, for all tests given, was used as denoting the relative standing of the various types of twins.

Table 7 shows that in every group the identical twins were superior to the fraternal twins and most nearly approached the average of the population as a whole. The total sampling represented is about 130 pairs. Merriman shows a lower mean I.Q. for the identical group than is shown by any other study. It must be remembered, however, that this group is less carefully selected and so very probably includes some fraternal twins. Moreover, his fraternal group very possibly includes some identical twins. The fraternal group, including like and unlike-sex twins, drops from 2.5 to 7.0 points below the identical group in I.Q. This group comprises 238 pairs of twins.

In the Thorndike data the differences are in the same direction. (See table 8.) The fraternal group score slightly below the mean for the entire group and the identical twins score considerably above this mean.

If the data presented by these various studies are on a representative sampling of twins, the consistency of the findings is evidence of a real difference in intelligence between identical and fraternal twins. The cause for such a difference brings up biological problems of great interest. Two of the factors suggested, as possibly entering into such a difference, are the mean occupational class represented by each group and the question of prematurity. Such data were available only for the twins of this study and are presented in table 9.

TABLE 8

Mean deviation score of twins (Thorndike)

	NUMBER OF CASES	MEAN DEVIATION SCORE
Like sex:		
Identical	22	+791.77
Fraternal	34	−26.35
Unlike sex	14	−126.57
All fraternal	48	−55.58

The occupational class differences favor the identical twins by .3 of an occupational class. It would be interesting to know whether or not the tendency for twins to develop from a single zygote is more prevalent among the upper classes than in the lower classes. The sampling is too small in

the present study to make sure that this difference is not due to selection. It is to be hoped, that in the future investigators will note the occupational class of the subjects.

The Goodenough (8) evaluation of the Kuhlman-Binet test was based upon 300 cases very carefully selected from the standpoint of occupational class. Goodenough says, "The differences between the mean I.Q. earned on the first examination by the children of parents belonging to the professional classes, and the corresponding rating for the children of day laborers amounts to approximately one and one-fourth standard deviations of the total distribution of I.Q.'s for the entire group." Goodenough's findings in this regard are in close agreement with the results of the army intelligence tests and those of Haggerty and Nash (11) based upon an examination of 6,688 New York State School children. The difference of .3 of an occupational class found in this study between the identical and fraternal groups, is no doubt a factor in causing the differences found between these groups in I.Q. It is, nevertheless, a question as to whether it is entirely accountable for the difference.

TABLE 9

Mean I.Q., occupational class and period of gestation like-sex and unlike-sex twins

TWINS	MEAN I.Q.	OCCUPATIONAL CLASS	PERIOD OF GESTATION
			weeks
Like sex:			
Identical	99.7	3.4	36.1
Fraternal	90.8	3.9	38.5
Unlike sex	96.2	3.5	39.9
All fraternal	92.8	3.7	39.2

It is a well known fact that twin births constitute a large proportion of the premature births. This is one factor in their high rate of mortality at birth. Capper (1) in an investigation of 437 immature infants, found that 72 per cent of them were born prematurely. Fourteen per cent of those born prematurely were twins. The mean period of gestation for 68 pairs in the present study was 38.4 weeks or 269 days. This is not apparently a startling variation since Capper says, "In obstetrics a mature infant is one born at term, i.e., at the end of from 270 to 290 days, irrespective of the degree of the development of the baby."

Table 9 shows that the identical group have the lowest mean period of gestation and are approximately one month premature. They are, however, the group with the highest mean I.Q. A correlation (Pearsonian r) of $+.03 \pm .067$ was obtained between I.Q. and the period of gestation for 102 twins. The correlation between birth weight and the period of gestation was found to be $-.44 \pm .054$ and between birth weight and I.Q. $+.05 \pm .062$. Since there is little relationship between, either the period of gestation and I.Q. or the birth weight and I.Q., prematurity cannot be a very significant factor in causing the differences in I.Q. between identical and fraternal twins. Gesell (7), in discussing the growth of the premature infant, says, "The maturation of the

central nervous system is perhaps least affected by the condition of prematurity. The head of the premature infant continues to grow in size at a relatively normal rate, even when his general bodily development is distinctly subnormal."

EFFECT OF LANGUAGE UPON THE MENTAL TEST SCORE

Thirteen of the 29 individual tests included in the Minnesota Pre-school Scale at this time, required a verbal response. Since the twins as a group were 6 points below average in I.Q., the question arose as to whether the intelligence test score had not been reduced by the twins' handicap in language. In order to check this point, the four year old group, which had a lower mean I.Q. than any other age group (91.), were matched with a control group of single children. Mental tests had been obtained on 35 of the four year old twins. These were matched as closely as possible with other cases, who had been given the same test. They were matched in regard to total test score, chronological age at time of testing, sex, and occupational class.

Table 10 shows the means of the various aspects matched, which were found for the two groups. It also shows the mean raw scores and percentage scores, determined separately, for the 13 verbal and the 16 non-verbal test items. These could not agree much more closely. It seems to the writer to show that the Minnesota Scale requires a minimum of language, as it was planned to do. At least, single children, who it has already been pointed out, have superior language ability, did not in this instance use their language ability any more effectively than did the twins. The language retardation of these four year old twins, does not seem to have been a factor in reducing the total test score and thus lowering the I.Q. It may be pointed out, however, that the test did not give an opportunity for the maximum use of language.

TABLE 10

Mean intelligence test score, age and occupational class of four year old twins and control group

	TWINS—MEANS	SINGLETON (CONTROLS)—MEANS
Occupational class	3.9	4.1
Chronological age*	4–2–3	4–2–7
Total test score	103.37	103.60
Raw verbal score	47.4	47.0
Raw non-verbal score	56.0	56.6
I.Q.†	90.7	93.6
Percentage verbal score	46.3	45.4
Percentage non-verbal score	53.7	54.6

* C.A. is stated in years, months and days.

† The apparent discrepancy in the differences found in I.Q., although the total test score and C.A. are the same is due to the fact that as the Minnesota Scale was still in process of standardization, the raw point score had not yet been transferred into equivalent scale values.

The relation between the language development and intelligence may be seen by the series of correlations presented in table 11. The Pearson product moment method of correlation was used.

It may be seen, that the McCarthy four year old singletons show a small positive correlation between length of

response deviation from the mean and I.Q. whereas the twins, of this age, show practically no correlation. Twins at 2, 3, and 5 years, however, show similar correlations of +.43 between mean length of response and 2 years 14.75, 3 years 12.83, 4 years 9.19, 5 years 14.00.

The four year old group, for some reason, shows a fairly high negative correlation (−.57) between the total score on the intelligence test and the

TABLE 11

Correlations between measures of language development and measures of intelligence

TRAITS CORRELATED	TWINS			SINGLETONS		
	Number of cases	r	P.E.	Number of cases	r	P.E.
I.Q. and mean length response 2 years	25	+.42	±.11			
I.Q. and mean length response 3 years	33	+.43	±.09			
I.Q. and mean length response 4 years	35	−.07	±.11			
I.Q. and mean length response 5 years	30	+.43	±.10			
Four-year age group:						
I.Q. and verbal score	35	+.40	.10			
I.Q. and non-verbal score	35	+.64	.07			
Mean length response and verbal score	35	−.04	.11			
Mean length response and non-verbal score	35	−.13	.11			
Length of response deviation from mean and I.Q.	35	−.08	.11	20	+.37	±.13*
Verbal and non-verbal scores	35	+.63	±.07	35	+.61	±.07†
Total test score and per cent verbal score	35	−.57	±.08	35	+.09	±.11†
Total test score and per cent non-verbal score	35	+.55	±.08	35	+.08	±.11†
Five-year age group:						
Total test score and per cent verbal score	30	+.01	±.12			

* Mc Carthy singletons.

† Control four-year old singletons.

I.Q. The lower, or practically zero, correlation of the 4 year old group, in this instance, is probably affected by the smaller standard deviation of I.Q.'s. The standard deviations of the distribution of I.Q.'s are as follows:

percentage of verbal score. Both the control group of singletons and the five year old twins show approximately a negative correlation between these same scores. It appears to be true, for these four year old twins, that

the lower the proportion of verbal score, the higher the total test score although such is not the case for five year old twins. It is open to question then, as to whether the relationship found in the four year old twins is to be interpreted as typical for twins in general, or whether it may be attributed to some phenomenon of this particular group of twins or what is perhaps more probable, of the test used.

COMPARATIVE RETARDATION OF TWINS IN LANGUAGE DEVELOPMENT AND GENERAL INTELLIGENCE

In order to compare the language retardation of the twins with their retardation in general intelligence, the mean length of response was converted into a language quotient. To do this the mean length of response of singletons for each age group was assumed as 100 or average. This involves error, since the McCarthy study is based upon only 20 children at each age. However, no other data were available.

The language age was determined by the following formula:

$$S : \text{"C.A."} :: T : X$$

"S" = the mean length of response for the singletons of a given age.[5]

"C.A." = the given age.

"T" = the mean length of response of the twins for the given age.

"X" = the language age.

$\frac{X}{C.A.}$ = the language quotient (L.Q.).

Table 12 shows the comparative retardation of twins in language development and general intelligence in terms of L.Q. and I.Q. The language retardation is so significantly greater, that factors other than "below average general intelligence" must be responsible for it. The language quotient decreases rapidly as age increases in spite of the fact that the intelligence quotient does not. Nevertheless, this increasing difference is not accompanied by a decreasing relationship between the two factors since the correlations between mean length of response and I.Q. show no consistent trend with age.

The twin situation differs markedly from the situation of a single child in but one respect and that is companionship. This difference begins in fetal life and is an environmental factor. It will have to be left for the biologists to tell whether or not, the development of two embryos may limit or reduce the inherited traits, and in what particulars. The differences between the mental ability of identical and fraternal twins suggests a nutritional difference in embryo. Since there are twice as many fraternal twins as identical twins, they would tend to pull down the mean I.Q. for twins as a whole, keeping it below 100. Aside from the possible inheritance of imperfect physiological factors concerned with speech, it seems more probable to expect the environmental factor to

[5] This figure (4.7) at 5 yrs. was taken from the Smith investigation. Her mean lengths of response at all ages agreed closely with the McCarthy findings. Smith, M.E. An Investigation of the Development of the Sentence and the Extent of Vocabulary in Young Children. Univ. of Iowa, Studies in Child Welfare, 3, No. 5. Iowa City, 1926. 92 pp.

have a limiting effect. One surely could not learn as much or as rapidly, from companionship with an individual so nearly on his own plane, as from one who was in advance. Satisfactions from this companionship may be adequate to the twin, whereas the single child may be motivated to gain his satisfactions from a wider field.

THE RESEMBLANCE OF THE TWINS

Basis for the selection of identical twins

The information obtained about the placentae proved to be too indefinite, in most cases, to be reliable. Likeness in hair and eye color and general appearance were found to be a more adequate basis for determining the identical twins. There were but five doubtful cases. One pair of girls, were finally classed as identical, as the only difference in them was a slight difference in size. The other four were all classed as fraternal due to slight differences in appearance.

The proportion of each type of twin having both identical hair and eyes is shown in Table 13. In approximately 50 per cent of the entire group these were similar although in only about 24 per cent, the identical group, was the appearance of the children also identical.

The development of the twins

The prematurity of the twins was discussed in connection with its relation to mental development. The mean birth weight was 2595.46 grams with a mean period of gestation of 269 days. The birth weight figures were taken from the mother's report. The hazard of this birth weight may be seen by Capper's statement, that of the 437 records of immature infants 145 weighed from 2,001 to 2,500 grams. The mortality of this group was 32 per cent by 6 years. The average birth weight for the population as a whole is between 3000 and 3500 grams.

Of the 68 pairs who had older brothers and sisters 42 per cent were reported by the mother as developing

TABLE 12

Comparative retardation of twins in language development and in general intelligence

	MEAN			
	2 years	3 years	4 years	5 years
Intelligence quotient	95.0	94.0	91.0	98.0
Language quotient	83.5	73.7	68.2	68.0

TABLE 13

The proportion of twins having identical hair and eyes

	NUMBER OF PAIRS	PER CENT OF TWIN GROUP	PER CENT OF LIKE HAIR AND EYE GROUP
Identical	18	94.7	46.2
Like sex fraternal	15	39.5	38.4
Unlike sex	6	26.1	15.4
All twins	39	48.75	

more slowly physically than the other children, 46 per cent were reported as developing about the same and 12 per cent faster than the older siblings. In the three twin groups, 35 per cent of the identicals developed more slowly than older siblings, 45 per cent of the fraternals were slower, and 39 per cent of the unlike sex.

The development of the twins in learning to talk and walk, and in cutting the first tooth is shown in table 14. The identical group shows a slight minus deviation from the mean in age of talking and walking but a plus deviation (.3) in age of cutting the first tooth. The like sex fraternal group show a plus deviation from the mean in all three activities. The unlike-sex twins show a plus deviation from the mean in age of talking but a minus deviation in the age of walking and of cutting the first tooth. The 68 pairs of twins having older siblings, show a mean age of talking approximately one month (.96 mos.) later than the mean age of talking for the older siblings. These data are based on the mother's report of the ages at which the children first talked, and are therefore subjective. Although the difference lies in the same direction as the language retardation of the twins found throughout this study the subjectivity of the data and the small number of cases did not warrant further analysis.

Both the twins and their siblings were late in beginning to talk. In consideration, however, of the subjectivity of the data, the fact that the twins began to talk at a later age than their siblings seems to be more significant, in denoting their retardation, than is the comparison with the norm.

The twins appear average in respect to age of walking according to Gesell's norm. The twins also cut their first teeth within the average time stated, which is 6 to 9 months.

TABLE 14

Mean age of beginning to talk, walk, and cut teeth

	TALKING		WALKING		CUTTING TEETH	
	Mean age	Deviation —mean	Mean age	Deviation —mean	Mean age	Deviation —mean
	months		*months*		*months*	
Identical	15.3	−1.7	14.6	−.3	8.4	+.3
Like sex fraternal	17.2	+.2	15.1	+.2	9.4	+1.3
Unlike sex	18.2	+1.2	14.8	.1	7.8	−.3
All twins	17.0		14.9		8.1	

Emotional resemblance. Sixty per cent of all the twins were reported as being different emotionally. However, only 32 per cent of the identical twins were thought to differ in this respect as compared with 72 per cent of the like sex fraternals and 65 per cent of the unlike-sex twins.

Leadership. In 75 per cent of the cases, one twin was reported as showing the qualities of a leader more than the other twin. This was reported as being the case in 37 per cent of the identical twins, 87 per cent of both the

like-sex and unlike-sex fraternal twins. In the unlike-sex twins the girl was reported as being the leader approximately twice as often as the boy.

Handedness. The handedness of the twins is based upon the mother's report and not upon a test of handedness. Thirty-four or 21.0 per cent of all the twins showed some tendency to left-handedness. Table 15 shows the proportion of each type of twin, who were right-handed, left-handed or ambidextrous.

Of the 34 twins having a tendency to use the left hand, 21 or 62 per cent were boys and 13 or 38 per cent were girls. Twenty-four per cent of the identical twins showed a tendency to use the left hand although only 11 per cent were positively left-handed. Fourteen per cent of the like-sex fraternal group showed such a tendency although only 9 per cent were positively left handed. Thirty per cent of the unlike sex twins inclined in this direction with seventeen per cent definitely left handed. There were only three pairs in which both twins tended to be left handed. One of these was a pair of fraternal girls, one an unlike-sex pair, and one a pair of identical boys.

Newman's theory of the "asymmetry mechanism" and its effect on the degree of likeness found between identical twins assumes that handedness is genetically determined. If this is true, one would expect to find the percentage of left handedness in twins of dizygotic origin equal to that in the population as a whole or about 4 to 5 per cent. Of the 122 fraternal twins in this group, 15 or 12 per cent were positively left handed and twenty-five or 20 per cent showed some tendency in that direction. Some other factor peculiar to the twin situation must be operative to increase the percentage to this extent. These data are not sufficiently reliable either in number of cases or in the method of determining handedness to draw any definite conclusions. In general, however, these findings are in agreement with those reported by others. Lauterbach found about 19 per cent of the two hundred pairs of twins were left handed. He did not distinguish any group as identical twins; however, of his 63 pairs of unlike sex twins about

TABLE 15

Handedness in twins

	PROPORTION OF ALL TWINS						PROPORTION OF TWINS WITH LEFT-HANDED TENDENCY	
	Right		Left		Both			
	Number	Per cent	Number	Per cent	Number	Per cent	Number	Per cent
Like sex:								
Identical	29	76	4	11	5	13	9	26
Fraternal	65	86	7	9	4	5	11	32
Unlike sex	82	80	8	17	6	13	14	42
All twins	126	79	19	12	15	9		

seven per cent were left handed. Newman summarizes the findings of Siemons (18), Weitz (21) and Dahlberg (2) on identical twins. Of the 124 pairs of identical twins in these investigations, 16.5 per cent were left handed. Dahlberg also studied 128 pairs of dizygotic twins and found 7 per cent to be left handed. Verschuer (20) found 16 per cent of 158 identical twins left handed and 13 per cent of 76 fraternal twins. Newman found 50 per cent of his 100 identical twins showing some left handedness and 15 per cent of the 100 fraternal pairs. Only 6 per cent of the fraternal group were very positively left handed. Gesell agrees with Newman that handedness is genetically determined. The fact that left handedness is sometimes a familial trait and is so frequent in twins he finds as a basis for this theory. It seems to the writer that the theory of intrauterine position as a factor causing left handedness, is supported by the frequency of left handedness in twins, especially by the fact that dizygotic twins show a higher percentage than the population as a whole.

Resemblance of the twins in general intelligence. Tables 16 and 17 show the correlations obtained for each age group and each type of twin, in the various measures of language development and in I.Q. The Pearson produce moment correlation was used throughout. In correlations between like-sex twins a shortened method of the double entry Pearsonian correlation as developed by Goodenough[6] was used.

[6] Goodenough, F. L., & Anderson, J. E. Experimental Child Study p. 239–243. Century Co., 1931.

The resemblance of the twins in general intelligence (r = +.72) is three to six points lower than that found by other investigators with one exception. The Wingfield data as reworked by the writer give an r = +.55 for all twins which is only a little higher than the resemblance given for siblings of +.50.

There are no consistent changes with age in this relationship. The correlation coefficient of +.85 of the two year olds is higher than the others, probably because nine of the twenty pairs of twins at this age are identical twins. The low correlation of the four year olds (+.37) appears to be due to the small distribution of the I.Q.'s (σ = 9.31). In agreement with the findings of Thorndike, Merriman, Lauterbach and Wingfield the coefficients of correlation for the older twins are not consistently greater than those for the younger twins.

The identical twins show a very close resemblance in general intelligence as shown by the correlation coefficient of +.92. Wingfield found a correlation coefficient of +.90 for this relationship and the writer of +.84 on Wingfield's data. The like-sex fraternal and unlike-sex groups show coefficients of +.61 and +.73 respectively. In the Wingfield data as reworked, these coefficients are +.21 and +.29. In both instances these appear to be reversed, since like-sex twins as a rule show closer resemblance than twins of unlike sex. This may be due in part to the smaller distribution of I.Q.'s in the case of both like sex fraternal groups. Why the Wingfield coefficients fall so far below that expected for twins is hard to determine. The sampling

TABLE 16

Correlations between twins at each age in language development and in I.Q.

	2 YEARS*			3 YEARS			4 YEARS			5 YEARS			ALL TWINS—AVERAGE r
	r	P.E.	σ	r	P.E.	σ	r	P.E.	σ	r	P.E.	σ	
Mean length response	+.59	±.10	0.45	+.26	±.14	0.6	+.23	±.15	0.9	+.50	±.11	1.2	+.39
Complete sentences	+.48	±.12	20.1	+.58	±.10	11.3	−.13	±.15	8.7	−.18	±.15	7.9	+.19
Incomplete sentences	+.51	±.12	15.6	+.53	±.11	11.3	−.22	±.14	8.5	−.15	±.15	8.0	+.14
Functionally complete but structurally incomplete	+.60	±.10	26.0	+.44	±.12	19.2	+.24	±.14	17.6	+.39	±.13	22.1	+.42
Simple sentences	+.21	±.14	11.3	+.34	±.13	15.6	+.00	±.15	11.3	+.38	±.13	12.9	+.23
Adapted information	+.49	±.11	22.3	+.06	±.15	16.0	+.09	±.15	14.6	+.22	±.14	20.5	+.21
Naming	+.57	±.10	16.0	+.44	±.12	12.9	−.33	±.13	11.6	+.55	±.10	18.2	+.31
Remarks about situation	+.36	±.13	11.0	+.72	±.07	13.6	−.11	±.15	11.7	+.21	±.14	14.1	+.29
Emotionally toned response	+.53	±.11	21.7	+.11	±.15	12.4	+.42	±.12	10.7	+.69	±.08	15.4	+.44
Questions	+.00	±.15	2.9	+.03	±.14	7.8	−.06	±.15	8.4	+.58	±.10	7.8	+.14
Answers	−.11	±.15	14.4	+.40	±.13	11.7	+.23	±.14	15.7	+.55	±.10	21.9	+.27
I.Q.	+.85	±.05	14.0	+.70	±.08	11.2	+.37	±.14	9.3	+.77	±.07	14.3	+.72† ±.042

* There were 20 pairs at each age except for I.Q. correlations. Here there were 12 pairs at 2 years, 16 pairs at 3 years, 17 pairs at 4 years, and 15 pairs at 5 years.

† This r is not an average but was plotted for 60 pairs twins, σ 12.52.

TABLE 17

Correlation between twins in language development and in I.Q.

	IDENTICAL (19 PAIRS)				LIKE SEX FRATERNAL (38 PAIRS)				UNLIKE SEX (23 PAIRS)				
	Raw	Age constant	P.E.	σ	Raw	Age constant	P.E.	σ	Raw	Age constant	P.E.	Boy	Girl
	r	r			r	r			r	r		σ	σ
Mean length response	+.89	+.80	±.04	1.21	+.42	+.28	±.10	1.1	+.63	+.40	±.12	0.8	1.1
Complete sentences	+.60	+.60	±.07	14.6	+.34	+.29	±.10	13.5	+.33	+.20	±.13	15.0	11.0
Incomplete sentences	+.53	+.53	±.08	14.4	+.36	+.31	±.10	9.4	+.31	+.22	±.14	14.5	11.2
Functionally complete but structurally incomplete	+.78	+.72	±.05	24.0	+.34	+.31	±.10	22.5	+.52	+.54	±.10	17.6	24.6
Simple sentences	+.64	+.51	±.08	15.4	+.52	+.44	±.09	14.4	+.22	+.18	±.14	12.7	18.8
Per cent total nouns	+.81		±.05	19.0	+.60		±.07	13.7	+.70		±.07	12.5	17.0
Per cent total verbs	+.67		±.08	10.3	+.19		±.10	9.11	+.48		±.10	6.7	11.4
Per cent total pronouns	+.59		±.10	8.9	+.47		±.09	8.8	+.44		±.11	7.0	7.5
Per cent total interjections	+.58		±.10	13.3	+.94		±.01	9.7	+.41		±.12	8.4	4.9
Ego-centric responses	+.56	+.52	±.08	13.4	+.02	−.04	±.10	11.9	+.58	+.53	±.10	15.5	14.4
Adapted information	+.36	+.29	±.10	21.3	+.27	+.25	±.10	18.4	+.56	+.51	±.10	16.4	20.7
Naming	+.39	+.38	±.09	13.6	+.19	+.18	±.11	13.6	+.61	+.61	±.09	16.7	18.9
Remarks about situation	+.52	+.44	±.09	16.1	+.29	+.23	±.10	23.9	+.63	+.61	±.09	11.2	13.8
Emotionally toned response	+.60	+.54	±.08	19.4	+.63	+.60	±.07	17.4	+.22	+.16	±.14	11.8	10.4
Questions	+.47	+.43	±.10	4.6	+.10	+.01	±.11	7.2	+.40	+.33	±.13	9.6	8.4
Answers	+.09	+.07	±.11	17.3	+.48	+.45	±.09	17.5	+.25	+.24	±.13	10.7	16.3
Mean coefficients		+.53				+.31				+.41			
I.Q.*	+.92		±.03	12.9	+.61		±.08	10.1	±.73		±.08	12.8	14.8

* For these correlations with I.Q. there were only 13 pairs of identical twins, 30 pairs of fraternal twins and 17 pairs of unlike-sex twins.

is relatively small, however, in all of these groups both in the Wingfield investigation and the present investigation.

The mean difference in I.Q. between the various twin groups is shown in Table 18.

As would be expected, the pairs of identical twins show consistently less difference in I.Q. than the pairs of fraternal twins. This corresponds to their closer resemblance in physical traits. Moreover, the pairs of like sex fraternal twins show less mean difference in I.Q. than the unlike sex twins in spite of the fact that the correlation between the I.Q.'s of unlike sex twins is greater than that between like-sex fraternals. This emphasizes the fact that correlations based upon different dispersions of measures are not comparable. It will be remembered that this like-sex group had a smaller standard deviation than the unlike sex group.

TABLE 18

Mean difference in I.Q. of twins

	DAY		WINGFIELD (178)		NEWMAN (114)	
	Number of pairs	Mean difference, I.Q.	Number of pairs	Mean difference, I.Q.	Number of pairs	Mean difference, I.Q.
Identical	13	3.46	45	6.23	50	5.3
Like sex fraternal	30	6.83	76	8.5		
Unlike sex	17	10.18	26	12.0		

Resemblance of the twins in measurements of language development. When considered from the standpoint of age groups, the correlation coefficients present negative, zero and positive relationships. In general the two year old group show the higher correlations and, as in the case of the I.Q.'s, this may be due largely to the large number of identical twins at two years. In Questions and Answers, both of which were found to increase considerably with age. Coefficients of the five year old of +.58 and +.55 show much greater relationship between the twins than those at any other age. Over the age period at which rapid change is taking place in any function, higher relations are found between the members of the pairs. In the use of complete and incomplete sentences the two and three year olds show coefficients around +.50 whereas a slight negative relationship appears at four and five years. There is not sufficient consistency in the changes of these correlation coefficients from age to age to show either that the twins grow more or less alike with age or even that their resemblance remains about the same.

The resemblance between twins of each type in measures of language development are also quite variable. In mean length of response and the phases of the construction of sentence analysis and word analysis with the exception of the percentage of interjections, identical twins show a consistently higher correlation than do the fraternal groups. In the functional

analysis, however, this is not true. In fact, with two exceptions (emotionally toned responses and answers) the unlike-sex group show closer resemblance. The phases of the functional analysis, because they are functional in nature might be expected to show less relationship between members of a pair than those, such as the phases of the construction analysis, which are of a developmental character.

The unlike-sex group show a correlation coefficient higher than the like-sex fraternal group in the functionally complete but structurally incomplete responses, the percentage of total nouns and percentage of total verbs. They show closer resemblance than either the like-sex fraternals or the identical group in ego centric responses, adapted information, naming, and questions. In all of these phases, however, the unlike-sex group show a larger distribution of measures, than the other groups, which in part will account for this.

The average resemblance in these measures of language development for identical twins is +.53, for like-sex fraternal twins, +.31 and for the unlike sex twins +.41.

Relation of certain environmental factors to the language development of the twins. An effort was made to find out how frequently stories were read or told to the twins in order to see if this affected in any way their language development. The estimate the mother made as to the frequency of reading stories was, of course, very rough. These estimates grouped themselves into four categories as follows:—the children were read to daily, several times a week, occasionally or not at all. Eighty-five per cent of the two year olds were not read to at all, as compared with 45 per cent of the three year olds, 15 per cent of the four year olds and 10 per cent of the five year olds. Since it seemed probable that the frequency of reading stories was related primarily to occupational status, occupational class was held constant in a correlation between frequency of reading stories and the mean length of response. A correlation coefficient of +.56 between frequency of reading stories and mean length of response was reduced to +.02 ±.533 when occupational class was partialed out. It becomes very evident with this zero correlation that frequency of reading stories had no relationship to mean length of response but was related to the occupational status of the family.

The effect of the imitation of the language of the twins, by other members of the family, on language development was determined by means of a bi-serial correlation between imitation of speech and mean length of response. In this instance, the imitation of speech could be grouped readily only into two categories: the cases that were imitated and those that were not imitated. The bi-serial r coefficient is −.35 showing a negative relationship between these two variables. This is in agreement with the popular belief that the imitation of the child's language is undesirable from the standpoint of the best language development. Moreover, in the twin situation, it only adds to the disadvantage resulting from the twins imitating each other. In approximately 33 per cent of the cases it was

reported that members of the family imitated the speech of twins.

Twinning in the ancestry

The information obtained in regard to twinning in the ancestry was not sufficiently specific to show exact relationships. Of the 68 pairs of twins from whom this information was obtained, 68 per cent had relatives who were twins; 26 per cent on the mother's side, a similar percentage on the father's side, and 16 per cent had twin relatives on both sides of the family. There was no striking difference in this respect between identical and fraternal twins with the exception that more of the former had twin relatives on both sides of the family (33 per cent). These data are based on so few cases, however, that such a difference is probably due to selection. Moreover, since comparable data for the general population are not available the significance of these percentages is highly uncertain.

SUMMARY

The results of these data may be summarized as follows:

1. Twins are below average in intelligence test performance. The 568 pairs of twins represented by the Merriman, Lauterbach, Freeman, Wingfield and present study had a mean I.Q. of 96.3.

2. Fraternal twins were found to be from 2 to 7 points below identical twins in general intelligence in the Merriman, Freeman, Wingfield and present investigations.

3. The language retardation of the twins did not reduce the total test score of the intelligence test. When the mean score on the verbal test items of the intelligence tests of the twins was compared with that of the control group they were found to be equal.

4. The language retardation of the twins in terms of "language quotient" is very much greater than is their retardation in general intelligence in terms of I.Q.

5. Identical twins were found to resemble one another much more closely than fraternal twins. A correlation coefficient of +.92 was found for identical twins in general intelligence as compared with +.61 and +.73 for the like-sex and unlike-sex fraternal twins. The mean coefficient of correlation for the identical twins in the various phases of language development was +.53 as compared with +.31 and +.41 for the like-sex and unlike-sex fraternal twins.

6. In agreement with the other studies the older twins showed about the same resemblance in the traits measured as the younger twins.

7. The twins of the present study, on the average, began to talk 1 month later than their older siblings.

8. They were not found to be retarded in age of beginning to walk or in the appearance of the first tooth, when compared with norms for the general population.

9. Twenty-one per cent of the group showed a tendency to be left-handed. This is similar to the findings of other studies of twins.

10. Sixty per cent of the twins differed emotionally although only 32 per cent of the identical twins were thought to differ in this respect.

11. In 75 per cent of the twin pairs,

1 was thought to be the leader. In unlike-sex pairs the girl was thought to be the leader twice as often as the boy.

REFERENCES

(1) CAPPER, AARON: The fate and development of the immature and of the premature child. Part 1. Amer. J. of Diseases of Children, 1928, **35**, no. 2, 262–288.

(2) DAHLBERG, G.: Twins births and twins from a hereditary point of view. Stockholm, 1926.

(3) DAVENPORT, C. B.: Heredity of twin births. Proc. Soc. Exp. Biol. and Med., 1920, **17**, 75–77.

(4) GALTON, F.: Inquiries into human faculty. History of twins, 1883, pp. 216–243.

(5) GESELL, ARNOLD: Mental and physical correspondence in twins. Scientific monthly, **14**, 305–344.

(6) GESELL, ARNOLD: The mental growth of the pre-school child. N. Y. MacMillan Co., 1925, pp. 447.

(7) GESELL, ARNOLD: Infancy and human growth. N. Y. MacMillan Co. 1928. 418. pp.

(8) GOODENOUGH, FLORENCE L.: The Kuhlman-Binet tests for children of preschool age. A critical study and evaluation. University of Minnesota Press, 146 pp.

(9) GOODENOUGH, F. L., FOSTER, J. C., AND VAN WAGENEN, M. J., Minnesota preschool scale. Minneapolis Educational Test Bureau Inc.

(10) GRANT, J. R.: A child's vocabulary and its growth. Ped. Sem., 1915, **22**, 183–203.

(11) HAGGERTY, M. E., AND NASH, H. B.: The mental capacity of children and paternal occupation. J. Educ. Psych., 1924, **15**, 559–572.

(12) LAUTERBACH, C. E. Studies in twin resemblancess. Genetics, 1925, **10**, 525–568.

(13) MCCARTHY, DOROTHEA A.: The language development of the preschool child. University of Minnesota, Institute of Child Welfare Monograph Series No. 4, Minneapolis, University of Minnesota Press, 1930, pp. 174.

(14) MERRIMAN, CURTIS: The intellectual development of twins. Psych. Rev. Monog., 1924, **33**, no. 5, 1–58.

(15) MULLER, H. J.: Mental traits und heredity. J. hered., 1925, **16**, 433–448.

(16) NEWMAN, H. H.: Studies of human twins. II. Asymmetry reversal of mirror imaging in identical twins. Biol. Bull., **55**, no. 4, 298–315.

(17) NEWMAN, H. H.: The biology of twins. Univ. of Chicago, Science Series, 1917, 185 pp.

(18) SIEMONS, H. W.: Die Bedeutungs der Zwillingspathologie fur die aetiologische Forschung elautert und Beispeil der Linkhanddigkeit. Setzungsber. 1. Ges. f. Morph. u. Physiol. in Munich. Jhg. 35.

(19) THORNDIKE, EDWARD L.: Measurements of twins. Archives of Philosophy, Psychology and Scientific Methods. No. 1, September, 1905, Columbia Univ. Contributions to Philosophy and Psychology, **13**, no. 3, 64 pp.

(20) VERSCHUER, O. VON: Die vererbungsbiologische Zwillingsforschung. Ihre biologischen Grundlagen. Studien an 102 eineligen und 45 gleichgeshlechelichen zweieigen Zwillings und an 2 Drillingspaarem. Ergebnisse der der Inneren Medizin u. Kinderheilk., 1927, **31**, 35–120.

(21) WEITZ, W. Studien an eineigen Zwillingen. Zeitsch. f. Klin. Med. Bd. 101.

(22) WINGFIELD, ALEX H. Twins and orphans. J. M. Dent and Sons, Ltd., 1928, 127 pp.

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